National Aeronautics and Space Administration

Demystifying Risk Assessment

NASA - Marshall Space Flight Center

Office of Strategic Analysis & Communication

Performance Analysis & Integration Office

Project Planning & Analysis Team

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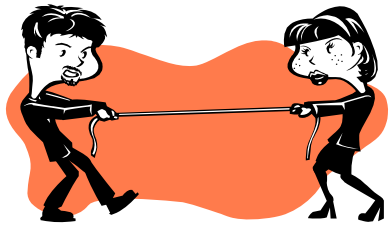
Background

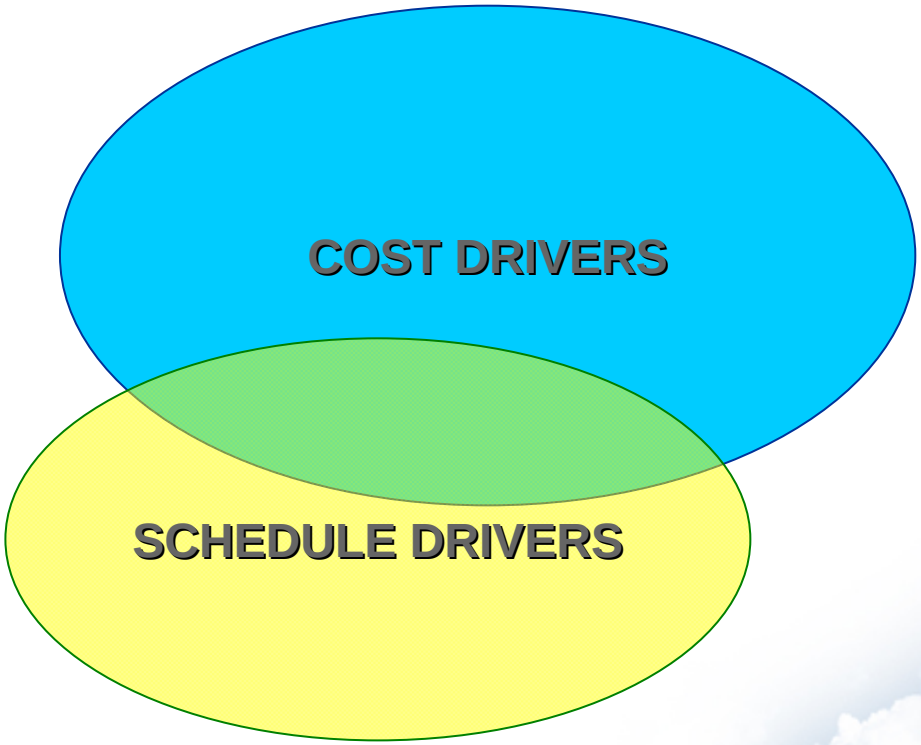
- MSFC is one of 10 NASA field centers
- OSAC responsibility includes PP&C and Risk Integration
- PAIO is the PP&C / Schedule Risk process owner
- PP&A owns schedule, EVM, related risk assessment, integration processes

Systems Engineering (**SE**) is an interdisciplinary field of engineering, that focuses on the development and organization of complex artificial systems. Systems Engineering integrates other disciplines and specialty groups into a team effort, forming a structured development process that proceeds from concept to production to operation and disposal. Systems Engineering considers both the business and the technical needs of all customers, with the goal of providing a quality product that meets the user needs.

- From Wikipedia, the free encyclopedia

Cost & Schedule Relationships





Quantitative Cost/Schedule Risk Assessment (C/SRA)

- Why do it?
  - To determine the probability of finishing on or before a given point in time for a given cost
  - To determine the time and cost requirements for required "confidence levels" – *NASA policy*
  - Because history keeps repeating itself…

NASA's Cost and Schedule Track Record

Study	Cost/Budget Growth		Percent of Projects Which Experienced Growth
	Average	Median	
NASA in the 90s	36%	26%	78%
NASA in the 70s	43%	26%	75%
NASA in the 80s			
Gruhl Study	61%	50%	95%
GAO Study	83%	60%	89%
DoD RDT&E	45%	27%	76%

Source: Hamaker & Schaffer 2004 Study
Note: Cost growth data are drawn from budget data and are based on growth from ATP to launch

- Current projects have exceeded their Phase B estimated launch dates by an average of about 56 percent respective cost estimate by 64 percent (Based on recent comparison of DoD to NASA performance)
- Cost and schedule growth
  - Adversely effects other projects in the portfolio
  - Damages our reputation and credibility with our Congressional stakeholders and therefore hampers our ability to obtain requested funds

Risk Assessment – Basic Process Flow Diagram

An Event Triggers the Need for Risk Assessment

Does the Model Meet Integrity Prerequisites?

No

Make Necessary Adjustments or Corrections

Yes

Establish Data Collection Method(s)

Collect Data

Set Minimum, Maximum, Most Likely Values

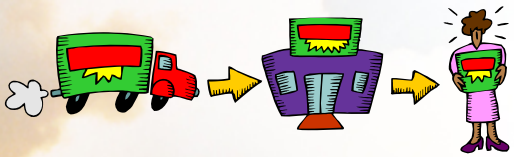
Assign Probability Distribution Curves

Evaluate for Special Conditions and Assign Values

Perform Risk Analysis Calculations

Analyze Results

Review Analysis with Stakeholders



Risk Assessment
Data Collection Methods

- Data collection methods, in order of accuracy:
  - *Data Interview* - Evaluate data points independently by reviewing data and interviewing personnel, then enter each data point discretely (most accurate method)
  - *Analogy/Historical* – Collect and evaluate data for the subject project or similar projects (accurate but subject to variation based on applicability)
  - *Grouping* – Assign risk parameters to data points that share common characteristics (not as accurate, but acceptable)
  - *Blanketing* – Assign risk parameters with a parametric across the entire project (not very accurate, can be difficult to validate or defend)
  - *Heuristic* – Make your best educated "guess" (very questionable basis or validity)

Risk Assessment
Data Collection Methods

- *Data Interview*
  - Individual Interviews (one on one)
  - Delphi Technique
  - Group Discussions
- *Analogy/Historical*
  - Data review (past similar)
  - Regression Analysis (current or past)

Risk Assessment
Data Collection Methods

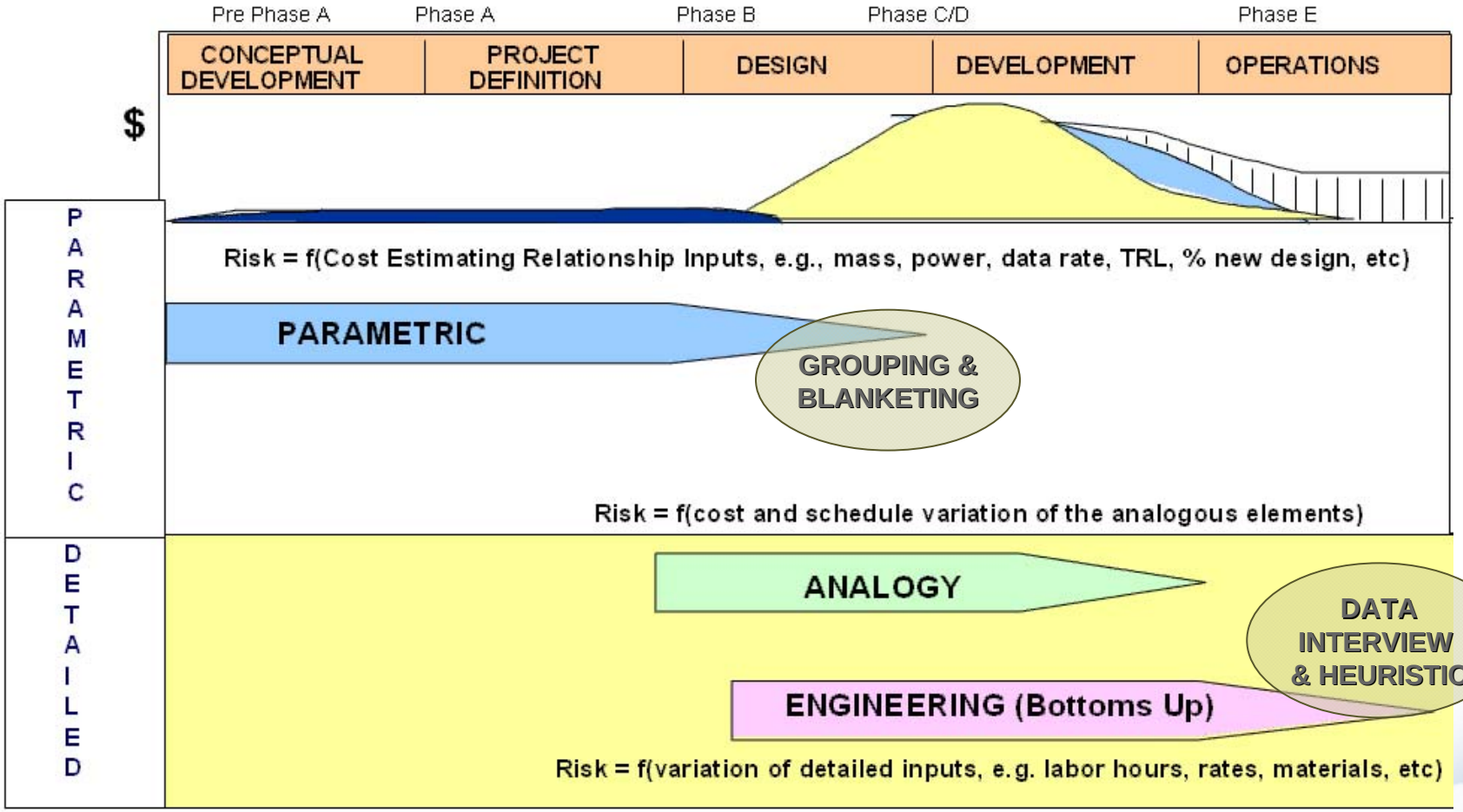
- *Grouping*
  - WBS
  - RBS
  - Risk Register
  - Duration

- *Blanketing*
  - Project Type
  - Weight, Volume, Power, Thrust
  - Time and/or Cost

- *Heuristic*
  - Analyst or Technical Expert Judgment

From a recent Agency briefing…

Different Cost Estimating Methods



Transparent ovals added to show correlation to previous slide…

Be aware…

- Summarization of detail results in larger ranges of output values

Source: Jimmy Black study, August 2004

Case	# Samples	Original Finish Date	50% Probability	80% Probability	100% Probability	Slipage % 50% Prob	Slipage % 80% Prob	Slipage % 100% Prob
100 Act 1 Day Dur	1000	01/07/2005	02/08/2005	02/10/2005	02/17/2005	32.00%	34.00%	41.00%
10 Act 10 Day Dur	1000	01/07/2005	02/08/2005	02/16/2005	03/10/2005	32.00%	40.00%	62.00%
1 Act 100 Day Dur	1000	01/07/2005	02/03/2005	03/07/2005	04/26/2005	27.00%	59.00%	109.00%
100 Act 1 Day Dur	10000	01/07/2005	02/08/2005	02/10/2005	02/18/2005	32.00%	34.00%	42.00%
10 Act 10 Day Dur	10000	01/07/2005	02/08/2005	02/16/2005	03/28/2005	32.00%	40.00%	80.00%
1 Act 100 Day Dur	10000	01/07/2005	02/03/2005	03/08/2005	04/29/2005	27.00%	60.00%	112.00%

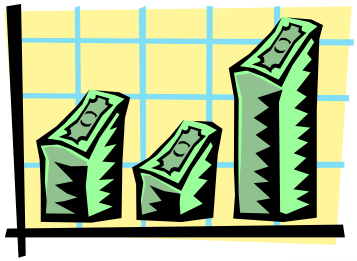
Be aware…

- With all other data values equal, the PDC affects output values

Source: Greg Smith study, August 2004

PDC	20%	80%	Range (1)	Density (2)	Rank (3)
Beta	2/24/03	3/4/03	8	0.42	1
Triangular	3/17/03	4/1/03	15	0.79	2
Normal	4/8/03	4/18/03	10	0.53	3
Uniform	4/4/03	4/23/03	19	1.00	4

- (1) – absolute difference between the 20% and 80% dates
- (2) – PDC range divided by Uniform PDC Range
- (3) – determined by optimism of 20% to 80% results

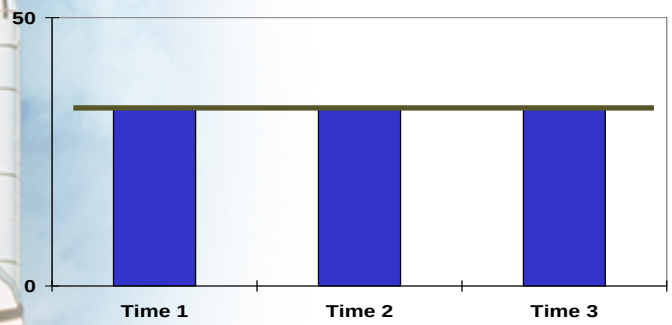


How do I pick the best PDC?

- How many identified risks and opportunities impact this event?
- What are the magnitude of the possible impacts?
- Are mitigation plans in place?
- Do we have control over any of these impacts?
- Are the risks and opportunities well defined?
- How confident am I in my data points?

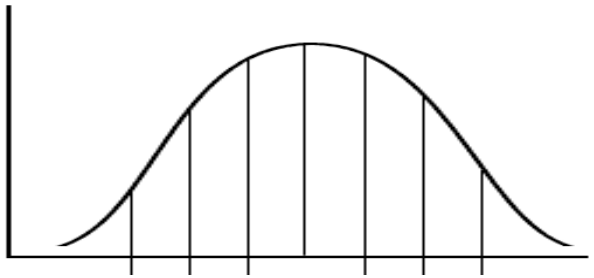
Common Probability Distribution Curves (PDC)

Uniform (flat)



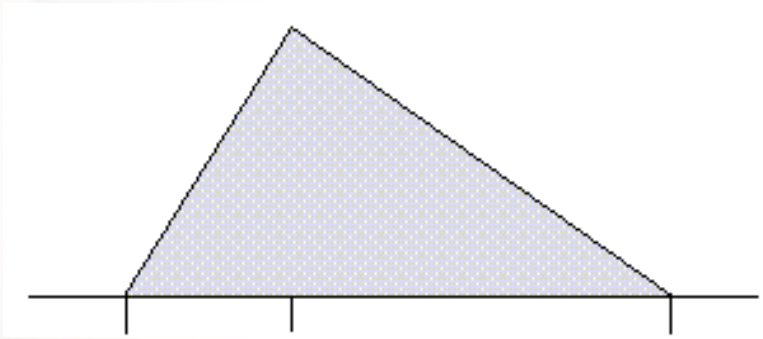
Normal (bell shaped)

Always symmetrical



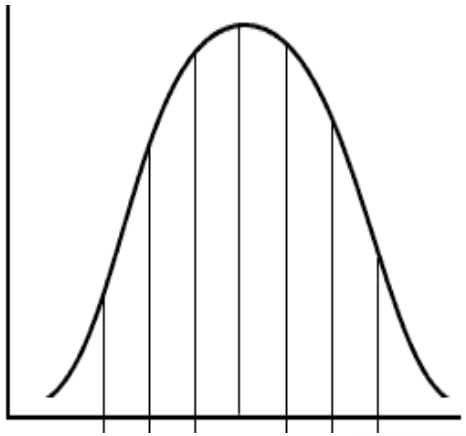
Triangular (pyramid shaped)

Can be symmetrical or asymmetrical



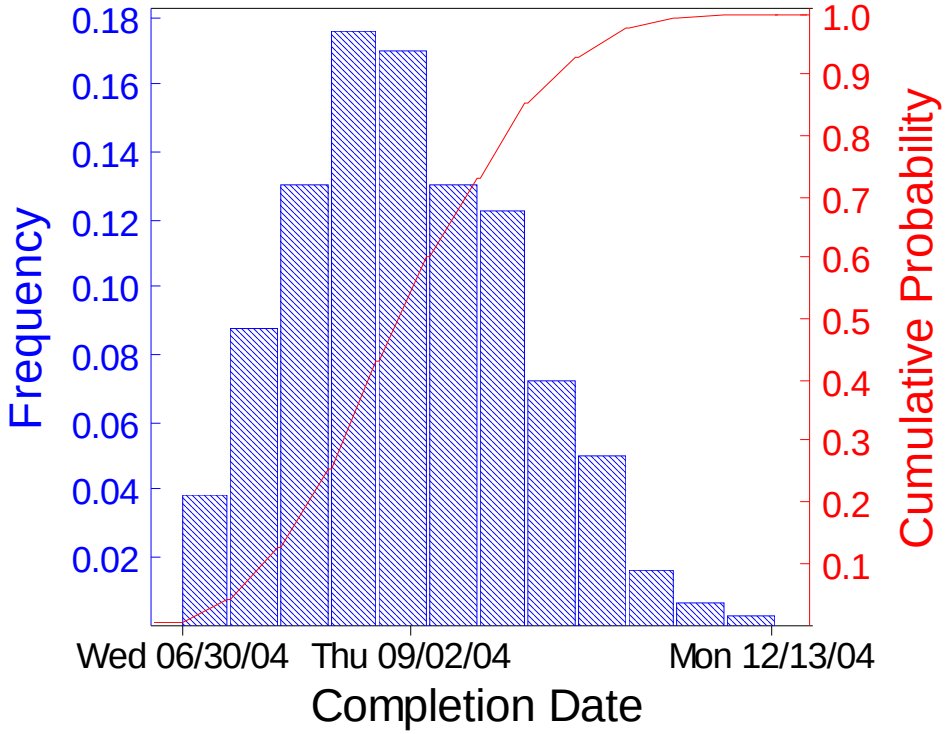
Beta (skinny bell shaped)

Can be symmetrical or asymmetrical



Schedule Risk Assessment Results Analysis

Date: 07/25/2002 9:58:36 AM
Samples: 500
Unique ID: 0
Name:



Initial Analysis (Duration -5% to +40%)

Completion Std Deviation: 22.09 d
95% Confidence Interval: 1.94 d
Each bar represents 10 d

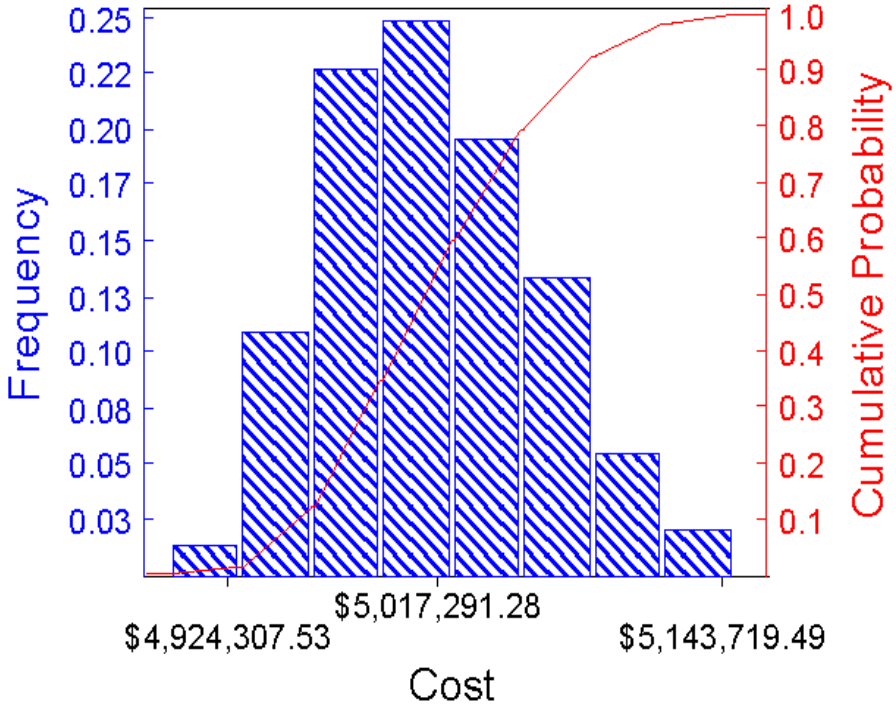
Completion Probability Table

Prob	Date	Prob	Date
0.05	Mon 07/19/04	0.55	Fri 09/03/04
0.10	Mon 07/26/04	0.60	Wed 09/08/04
0.15	Fri 07/30/04	0.65	Tue 09/14/04
0.20	Thu 08/05/04	0.70	Fri 09/17/04
0.25	Wed 08/11/04	0.75	Fri 09/24/04
0.30	Tue 08/17/04	0.80	Wed 09/29/04
0.35	Thu 08/19/04	0.85	Wed 10/06/04
0.40	Tue 08/24/04	0.90	Thu 10/14/04
0.45	Fri 08/27/04	0.95	Wed 10/27/04
0.50	Tue 08/31/04	1.00	Mon 12/13/04

Scheduled Completion - 8/22/04

Cost Risk Assessment
Results Analysis

Date: 11/10/2003 2:47:22 PM
Samples: 1000
Unique ID: 1
Name:



11th run - revised CS FTE and other costs

Cost Standard Deviation: $37,342.91
95% Confidence Interval: $2,314.54
Each bar represents $25,000.00

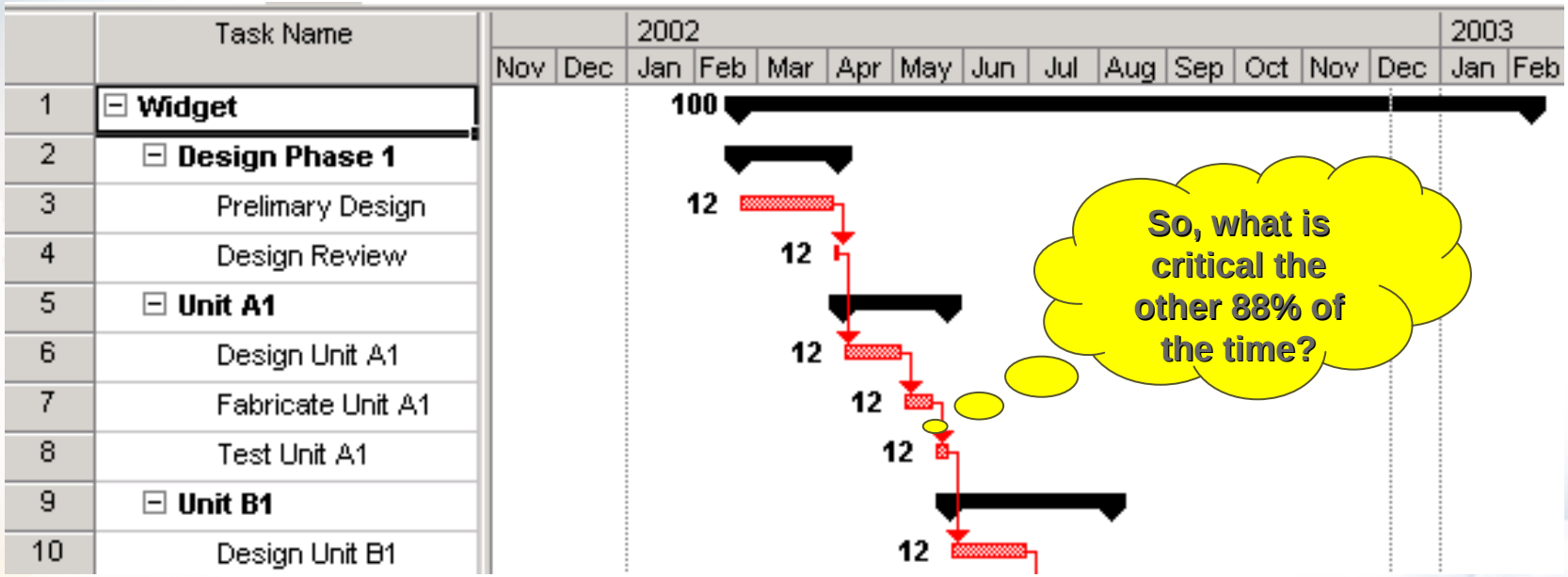
Cost Probability Table

Prob	Cost	Prob	Cost
0.05	$4,961,993.77	0.55	$5,018,696.98
0.10	$4,971,284.06	0.60	$5,024,439.88
0.15	$4,978,578.14	0.65	$5,030,154.81
0.20	$4,984,960.83	0.70	$5,037,085.72
0.25	$4,989,130.03	0.75	$5,043,163.95
0.30	$4,995,243.23	0.80	$5,049,927.99
0.35	$4,999,294.36	0.85	$5,057,663.15
0.40	$5,003,588.40	0.90	$5,067,874.77
0.45	$5,008,437.29	0.95	$5,079,801.44
0.50	$5,013,328.90	1.00	$5,143,719.49

Budget - $4.9 M

Risk Critical Analysis

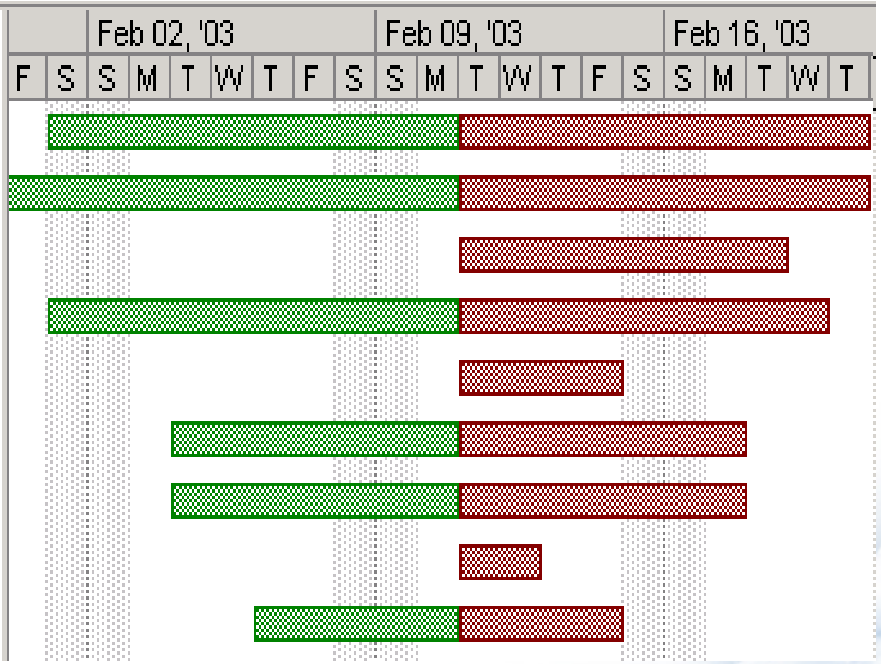
- Indicates whether or not a task is “risk critical” (i.e. during calculations, whether or not it becomes a Critical Path task)
  - Critical Path – the string of tasks that dictates the completion date
  - May not always be technically “critical”
- If a task becomes critical, the tool indicates percentage of time the task is critical during simulation



Sensitivity Analysis

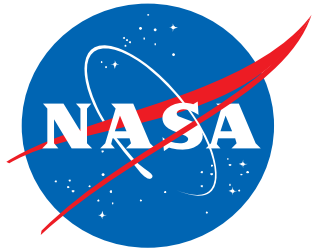
- Indicates the potential impact an activity has on the overall project or program completion
  - Intersection of red and green indicates current schedule project completion
  - Red is threat potential
  - Green is opportunity potential

	Task Name	Rept ID	Min Rdur	ML Rdur	Max Rdur
3	Prelimary Design	1	22.5d	30d	37.5d
4	Design Unit C	0	22.5d	30d	37.5d
14	Prelimary Design	0	26.6d	28d	39.2d
15	Design Unit B1	0	18.75d	25d	31.25d
22	Design Unit B2	0	23.75d	25d	35d
7	Design Unit A1	0	15d	20d	25d
26	Fabricate Unit C	0	15d	20d	25d
18	Design Unit A2	0	17.1d	18d	25.2d
12	Test Unit B1	0	11.25d	15d	18.75d



How To Use The Results

- Gain an understanding of the probability of completing by a certain date & cost
  - Use to establish contingency or reserve
  - Monitor the contingency as it gets used
- Understand where the risk areas are so they can be monitored and proactively managed
  - Sensitivity Analysis
  - Risk Critical Analysis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